SELF-TENSIONING CONVEYOR

This application claims the benefit of U.S. Provisional Patent Application Ser. Nos. 60/435,221 and 60/509,999, the disclosures of which are incorporated herein by reference.

Technical Field

The present invention relates to the conveyor art and, more particularly, to a conveyor with self-tensioning capability.

Background of the Invention

Today, many modern manufacturing facilities extensively utilize modular conveyor systems to transport articles to and from various work stations during all stages of production. In recent years, manufacturers using production lines with conveyors as an integral component of the material handling system have realized reasonably significant gains in productivity and resource utilization. As a result, modular conveyor systems have become even more widely implemented and have been adapted to meet an even wider scope of the material handling needs of producers of a multitude of consumer and industrial goods. Therefore, the continual development of improved modular conveyors is necessary to keep pace with the demands and expectations of the users of such conveyors.

Conventional conveyor systems employing endless, modular link belts or chains are typically driven at one end of an elongated guide structure, frame or "bed" supported above the ground. The force for driving the belt or chain is transmitted from a motive device, such as a variable speed electric motor, to a rotating drum or a plurality of gang-driven sprockets coupled to a rotating drive structure, such as a shaft. At the opposite end of the guide structure or bed, idler sprockets are coupled to a freely-rotating idler shaft or drum. As should be appreciated, these structures assist in supporting and guiding the endless belt or chain as it makes the transition from the forward run to the return run, or vice versa, at each respective end of the guide structure. Intermediate drive units, including frictional drives, may also be used in place of or in addition to the end drive unit.

Oftentimes, a plurality of laterally repeating modular links, or unitary link sections comprising a plurality of laterally repeating link-shaped structures (collectively referred to as "links"), form the conveyor chain or belt. The links are typically formed of a low-cost, high strength, wear resistant material, such as Acetal or UHMW polypropylene. To form the chain or belt, a plurality of links or link sections are positioned in interdigitating, longitudinally repeating rows. Each row is then connected to the adjacent row by a transverse connecting rod that projects through one or more apertures in a first, usually leading portion of a first link or link section and one or more apertures or slots in a second, or trailing portion of the next-adjacent link or link section. At both lateral ends of each row, special side links are used that include slots for receiving a locking structure, such as a tab, that retains the transverse connector rod in place. Examples of this type of arrangement are found in commonly assigned U.S. Patent Nos. 4,953,693 and 5,031,757, the disclosures of which are incorporated herein by reference. Due to their low-

cost, adaptability and long service life, chains or belts formed in this fashion have gained widespread acceptance among those seeking conveying solutions.

In the past, others have recognized the potential value of a "micropitch" chain formed of a plurality of interconnected links, but capable of behaving almost like it is formed of a continuous piece of material, such as a belt formed of a piece of rubber or fabric. An example is found in U.S. Patent No. 5,967,296 to Dolan, which discloses a belt including a plurality of link sections including laterally and longitudinally offset spherical beads having apertures for receiving a plastic transverse connector rod. Once inserted through the aligned apertures in a pair of interdigitated link sections, both ends of the connector rod are mutilated, such as by melting. This captures the rod in place between the link sections to form a belt section. One improved version of a micropitch chain that advantageously avoids the need for separate connector rods is found in Applicant's co-pending application Ser. No. PCT US03/05666, which is incorporated herein by reference.

Modular conveyor systems often include two or more conveyors strategically positioned in an end-to-end relationship so as to move articles along a feed path in a conveying direction. This type of arrangement is especially beneficial in the food processing or packaging industries, and where space availability is sometimes limited. However, a prevalent problem with such an end-to-end conveyor system is the lack of a compact, driven transfer conveyor including a belt or chain that efficiently and effectively provides for the smooth transition of articles along a transfer zone established between the ends of the adjacent conveyors.

In this regard, the '296 patent to Dolan proposes the use of a small pitch chain in a transfer conveyor in which the driving force is provided by a smooth surface drive roller, as opposed to a sprocket. However, the

combined requirements of a separate electric motor for driving the belt associated with the transfer conveyor and a complicated, non-reversible tensioning assembly are deleterious, since these features increase not only the space requirements, but also the manufacturing and maintenance expense.

Accordingly, a need is identified for an improved, conveyor with self-tensioning capabilities that may be used for efficiently and effectively conveying articles, including between the ends of two adjacent conveyors at a transfer location.

Summary of the Invention

In accordance with a first aspect of the invention, a conveyor for intended positioning in a gap between the ends of first and second adjacent conveyors and including an endless belt or chain having a conveying surface and an inner surface is disclosed. The conveyor comprises a bed for supporting the endless chain, a drive structure for driving the chain relative to the bed in a conveying direction, and first and second idler structures spaced apart in the conveying direction for assisting the chain in making the transition to and from the bed to the drive structure. A frame supporting the drive structure is pivotally mounted. This allows the drive structure to engage the inner surface of the belt or chain and tension it.

In one embodiment, the bed includes rounded leading and trailing edges for assisting the chain in making the transition between the forward and the return runs. The frame may be supported by an end of one of the first or second conveyors. Further, the drive structure is a support shaft extending between first and second spaced frame members forming the frame and includes a plurality of gang-mounted sprockets for engaging and driving the chain. Preferably, drive structure is driven by a drive unit associated with

the corresponding first or second conveyor from which the frame members are supported. The support shaft may include a driven sprocket for engaging a drive chain or belt driven by a sprocket carried by a portion of a drive shaft extending from a drive unit associated with the corresponding first or second conveyor from which the frame members are supported.

Means for urging the support shaft away from the inner surface of the chain may also be provided. Preferably, the urging means is a constant force spring. The spring may engage a stub shaft projecting from each of first and second frame members comprising the frame.

Preferably, each idler structure is a rotatably supported roll. At least one of the rolls may carry a plurality of O-rings seated in annular grooves. The chain may also be formed of links in snap-fit engagement, including with gaps for engaging the O-rings to create a guiding or centering function.

In accordance with a second aspect of the invention, a conveyor for intended use in the gap between a discharge end of a first conveyor having a drive unit and the infeed end of a second conveyor and including an endless belt or chain is disclosed. The conveyor comprises a frame including a tensioner, a drive structure supported by the frame for driving the belt or chain, a bed supported by the frame and supporting the belt or chain, and a pair of idler structures supported by the frame for engaging the belt or chain. A slave drive transmits rotational motion from the drive unit of the first or second conveyor to the drive structure for driving the belt or chain.

In one embodiment, the slave drive comprises a first sprocket connected to a drive shaft projecting from the drive unit, a second sprocket connected to the drive structure, and a transmission chain or belt extending around the first and second sprockets. The frame may include a pair of spaced

side frame members, each with a slot for receiving the end of the idler structure associated with the tensioner such that the corresponding idler structure is capable of moving to and fro within the slots.

The tensioner may comprise first and second frame members for supporting the drive structure, and the frame may include third and fourth frame members for supporting the idler structures. The first and second frame members are mounted for pivoting movement relative to the third and fourth frame members to urge the drive structure into engagement with an inner surface of the belt or chain. The first and second frame members thus form part of both the frame and the tensioner.

Still another alterative is for the tensioner to include a spring for urging each end of the corresponding idler structure into engagement with the chain. Preferably, the springs are constant force springs. A locking device may be provided for holding the idler structure in a non-engaged position relative to the chain once the urging force supplied by the corresponding spring is overcome.

Yet another alternative is for the tensioner to include a pair of spaced arms mounted for pivoting movement. Each arm includes a finger at one end for engaging the idler structure and a weight at the opposite end for causing the arms to pivot. The finger thus urges the idler structure toward the adjacent chain to provide the desired tension.

In accordance with a third aspect of the invention, a conveyor adapted to be positioned in the gap between a discharge end of a first conveyor having a drive unit and the infeed end of a second conveyor is disclosed. The conveyor comprises a frame, a drive structure a bed, and a pair of idler structures, all supported by the frame. An endless belt or chain associated with the bed, the idler structures, and the drive structure follows a

generally T-shaped path of travel when driven. The belt or chain includes a conveying surface, and a tensioner is provided for urging at least one of the idler structures into engagement with the conveying surface of the belt or chain.

In one embodiment, the tensioner includes a constant force spring for urging each side of the one idler structure into engagement with the conveying surface. Preferably, the orientation of each constant force spring is reversible for urging the ends of the other idler structure into engagement with the belt or chain. The chain may be driven at the same speed as a belt or chain of the first or second conveyor, or at a different speed.

In accordance with a fourth aspect of the invention, a conveyor adapted to be positioned in the gap between a discharge end of one conveyor having a drive unit and the infeed end of another conveyor and including an endless belt or chain is provided. The conveyor comprises a frame and a drive structure supported by the frame. A bed is provided for supporting the chain and includes a transverse support structure supported by the frame. A pair of idler structures are supported by the frame, and a tensioner is provided for urging one of the idler structures into engagement with the belt or chain. The frame includes notches, each for receiving one end of the support structure associated with the bed when in a mounted position. Consequently, the bed is easily moved from the mounted position when the belt or chain is slackened or removed.

In one embodiment, each notch is generally vertically oriented. The bed may include a wear structure for engaging an inner surface of the belt or chain. The wear structure may be comprised of a plurality of pieces of a plate-like, wear-resistant material.

In accordance with a fifth aspect of the invention, a conveyor

is adapted to be positioned in the gap between a discharge end of one conveyor having a drive unit and the infeed end of another conveyor. The conveyor comprises a frame; a drive structure supported by the frame; a bed supported by the frame; first and second idler structures supported by the frame; an endless belt or chain extending in an operative position along the bed and around the idler structures and drive structure and forming a T-shaped path including a return run having a first generally horizontal portion, a non-horizontal portion, and a second horizontal portion; and a tensioner for tensioning the belt or chain. The first idler structure guides the belt or chain from the first horizontal portion of the return run to the non-horizontal portion, and the second idler structure guides the belt or chain from the non-horizontal portion to the second horizontal portion.

In one embodiment, the tensioner includes a constant force spring for urging each end of the first idler structure toward the other idler structure, which is fixedly mounted. The tensioner includes a retaining plate or cover for covering the constant force spring. The retaining plate or cover includes a first, oversized opening for receiving and allowing the first idler structure to move into engagement with the belt or chain as a result or the urging force supplied by the constant force spring and a second opening for receiving and fixing the position of the second idler structure. Preferably, the positions of the constant force spring and the retaining plate are reversible such that the first idler structure is fixed in the second opening and the second idler structure is movable in the first opening.

In another embodiment, the tensioner comprises a pair of spaced arms mounted for pivoting movement. Each arm includes a finger at one end for engaging the idler structure and a weight at the opposite end for causing the arms to pivot such that the finger urges the idler structure toward the

adjacent chain.

In accordance with a sixth aspect of the invention, a conveyor for intended use in positioning in a gap between the ends of first and second adjacent conveyors is provided. The conveyor comprises a bed assembly including an endless belt or chain, a bed for supporting the endless chain, a drive structure for driving the chain relative to the bed, and first and second idler structures for assisting in guiding the chain. At least one of the drive or idler structures is movable for tensioning the belt or chain. A base is adapted for attachment to an end of one of the first and second adjacent conveyors for supporting the bed assembly, such that the bed assembly may be bodily lifted from the base without removing or slackening the chain.

In accordance with a seventh aspect of the invention, a transfer conveyor for a conveyor system including a first conveyor having a feeding portion, a second conveyor having a receiving portion and a frame between the feeding and receiving portions. The transfer conveyor comprises a conveyor chain or belt driven in an endless path and defining a conveying surface for moving the articles from the feeding portion to the receiving portion. The transfer conveyor is freely resting by gravity on the frame and substantially fully releasable therefrom. Consequently, in the event of an article jam or the like, the transfer assembly may be bodily lifted and released.

In one embodiment, the frame comprises a base including a pair of U-shaped cutouts for receiving the ends of a driven shaft of the transfer conveyor. The frame may further comprise a pair of notches for receiving detents associated with the transfer assembly. The transfer conveyor may further comprise a pair of spaced side frame members, a drive structure supported by the side frame members, a bed supported by the side frame members, a pair of idler structures supported by the side frame members, and

a tensioner including a pair of spaced arms mounted for pivoting movement. Each arm includes a finger at one end for engaging the idler structure and a weight at the opposite end for causing the arms to pivot such that the finger urges the idler structure into engagement with the chain.

In one embodiment, a slave drive for transmits rotational motion from a drive unit associated with the first or second conveyor to a drive structure for driving the belt or chain associated with the transfer assembly. The need for a separate drive unit associated with the transfer conveyor is thus eliminated.

In accordance with an eighth aspect of the invention, a conveyor for intended use in positioning in a gap between the ends of first and second adjacent conveyors and including an endless belt or chain is disclosed. The conveyor comprises a frame, a bed supported by the frame for supporting the chain, a drive structure supported by the frame for driving the chain, first and second idler structures supported by the frame for guiding the chain; and a tensioner including a pair of spaced arms mounted for pivoting movement relative to the frame, each including a finger at one end for engaging the idler structure and a weight at the opposite end for causing the arms to pivot such that the finger urges the idler structure toward the adjacent chain. The engagement with the drive structure serves to tension the belt or chain in the conveyor.

Brief Description of the Drawings

The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of the present invention and, together with the description, serve to explain the principles of the invention.

In the drawings:

Figure 1 is a side schematic view of a conveyor forming one aspect of the present invention positioned adjacent to the discharge end of a conveyor;

Figures 1a-1c are top and side views of an exemplary form of a chain for use with the disclosed conveyors;

Figure 2 is a perspective view of one embodiment of a fully assembled conveyor for possible use in a transfer arrangement;

Figure 3 is a different perspective view of the conveyor of Figure 2 in a partially disassembled state;

Figure 4 is another perspective view of the conveyor of Figure 3;

Figure 5 is a perspective view of the conveyor of Figures 3 and 4 with the bed section removed;

Figure 6 is a perspective view of the conveyor of Figures 3 and 4 with the drive sprocket removed;

Figure 7 is a perspective view of the conveyor of Figures 3 and 4;

Figure 8 is a perspective view of a second embodiment of a conveyor for possible use in a transfer arrangement;

Figure 9 is a perspective view of one side of the conveyor of Figure 8 in a partially disassembled state;

Figure 10 is a side view of the conveyor of Figure 8;

Figure 11 is a partially exploded perspective view of the conveyor of Figure 8;

Figure 12 is an enlarged side view of the conveyor of Figure 9;

Figure 13 is an exploded perspective view of one side of the conveyor of Figure 8;

Figure 14 is a perspective view similar to Figure 13 taken from a different vantage point;

Figure 15 is a perspective view of the other side of the conveyor of Figure 8;

Figure 16 is a partially exploded view of the side of the conveyor shown in Figure 15;

Figure 17 is an exploded view of a third embodiment of a conveyor for possible use in a transfer arrangement;

Figure 18 is a perspective view of another embodiment of a conveyor for possible use in a transfer arrangement;

Figure 19 is a partially exploded view of the bed subassembly of the conveyor of Figure 18;

Figure 20 is an enlarged exploded view of one side of the bed subassembly;

Figure 21 is an exploded view of a tensioner forming part of the bed subassembly in the embodiment of Figure 20;

Figure 22 is a partially cross-sectional side view of the conveyor of Figure 20 used in a transfer arrangement;

Figure 23 is a partially exploded view of the bed subassembly of Figure 20; and

Figure 24 is a side view of the assembled bed subassembly.

Detailed Description of the Invention

With reference to the side schematic view of Figure 1, a conveyor 10 constructed in accordance with one embodiment of the present invention is disclosed. The conveyor 10 may be positioned adjacent to a discharge end of a first conveyor 12 and the infeed end of a second, adjacent

conveyor (not shown) and functions to assist articles being conveyed in making the transition between the two conveyors (called a "transfer conveyor" in the vernacular). The conveyor 12 is of the endless variety and, thus, includes an continuous belt B (fabric, rubber, link, etc.), modular link chain, or like structure that transitions from a forward to a return run adjacent to one end of the transfer conveyor 10. The conveyor 10 also includes a conveying medium, such as a belt or chain C, which may be of the type disclosed in Applicant's co-pending application Ser. No. PCT US03/05666. An example of one type of chain C formed of links is shown in Figures 1a-1c (note links L_1, L_2 connected in snap-fit engagement and including laterally repeating sections L_3 defining gaps G). In cases where such a chain C is used with the upstream conveyor 12, the corresponding bed 11 associated with a support structure or frame may include a plurality of spaced rails R for engaging the gaps G (see Figure 3). A bridge structure S (sometimes called a finger plate, finger bar, comb, etc.) may also be provided for assisting articles being conveyed in making the transition from the adjacent conveyor 12 to the conveyor 10 (and may be part of the conveyor, as described further below).

Now describing the basic structures comprising the conveyor 10 of this embodiment, and with continued reference to Figure 1, a bed 14 supports the chain C by engaging the underside surface along an article conveying or transfer "zone" Z. As perhaps best shown in Figures 2, 3, and 4, the bed 14 is preferably comprised of a thin, plate-like structure fabricated of a wear-resistant material (food grade ultra-high molecular weight (UHMW) polypropylene), aluminum (preferably extruded), or a non wear-resistant material with a wear-resistant coating). The bed 14 may be a unitary structure or, as shown, may optionally comprise a plurality of opposed pairs of relatively thin (e.g., 1/4") plates 14a, 14b.

Each plate 14a, 14b includes at least one rounded edge or end defining a "nose" or "nose bar" for engaging the chain C as it transitions between the forward and the return run along the conveyor 10 (such as in the direction of action arrow A, which corresponds to the conveying direction when the conveyor 12 is considered in an upstream position). Preferably, the "nose bar" created by each plate 14a, 14b is sized so as to correspond to the minimum turning radius of the chain C (e.g., about 6 millimeters for the chain disclosed in Figures 2a-2c and having a corresponding turning radius). The plates 14a, 14b may have different major dimensions (lengths) such that those along the entry end of the conveyor 10 overlap with a recessed portion of the bridge structure S and, therefore, eliminate any gap that may otherwise be present.

As perhaps best understood with reference to Figures 1, 3 and 4, the plates 14a, 14b are secured by fasteners F to a cross member 16 extending between a frame including a pair of side frame members 18, 20. The cross member 16 may be a unitary structure, or optionally may be in the form of a plurality of support structures 16a . . .16n (see Figure 7), each for supporting an opposed pair of the wear-resistant plates 14a, 14b. The support structures 16a . . .16b may rest on and be supported by a transversely extending cross bar 17, the ends of which rest in notches (not numbered) formed in the side frame members 18, 20. The notches are preferably vertically oriented, which allows for the entire bed 14 to be easily bodily lifted and removed once the chain C is slackened or removed altogether. This of course facilitates removing a jam as well as servicing of the conveyor 10. In operation, the tension supplied to the chain C (see below) helps to create a hold down force that keeps the bed 14 securely held in the operative position, while the engagement between the cross bar 17 and the notches resists any

movement in the direction of travel of the chain C.

Providing a wear structure comprised of a plurality of unitized, modular assemblies, such as the support structures 16a . . . 16n and the plates 14a, 14b, make this arrangement adaptable for use in any width of transfer conveyor 10 (which normally depends on the width of the adjacent conveyors, such as conveyor 12). However, as mentioned above, the use of a single support structure 16 for supporting a single wear plate (not shown) is entirely possible. The side frame members 18, 20 may also support the bridge structure S (such as by including notches for receiving an outwardly projecting portion of this structure similar to the cross bar 17), and may be connected by a transversely extending structural member, such as a tie rod 19 (see Figure 7). This allows the bridge structure S to be easily lifted from the operative position for cleaning or in the event of a jam.

The conveyor 10 also includes idler structures for engaging the chain C as it moves along the return run. These structures may be fixed or stationary shafts or rolls 22, 24 supported by the side frame members 18, 20 and spaced from each other in the conveying direction (that is, in the direction defined by action arrow A in Figure 1). When the rolls 22, 24 are adapted for rotation, bearings (not shown) may be supported by each side frame member 18, 20 and may be covered by a suitable cover or housing 26 (see Figures 4 and 7) to prevent external interference. In either case, the rolls 22, 24 may be provided with a wear-resistant coating or wear-resistant structures (which may also be high-friction structures to prevent slipping, which is preferable in cases where the idler rolls are rotatable).

In one possible embodiment, as shown in Figure 7, the wear resistant structures may be in the form of O-rings O for engaging the outside surface of the chain C as it moves through the conveyor 10. The O-rings O

may be seated in annular grooves or depressions formed in the roll 22, 24. In the case where the chain C is a version with gaps between laterally repeating sections (note reference character G in Figure 2), the O-rings O are strategically positioned to "ride" in this gap and engage the chain C as it moves along. This not only reduces the wear on the conveying surface (which is the portion of the links between the gaps), but also helps to guide or center the chain C.

The chain C is driven through the conveyor 10 by a drive structure. In the illustrated embodiment, and as perhaps best understood with reference to Figures 1, 4, 5, and 7, the drive structure comprises a plurality of spaced drive sprockets 28 supported and gang driven by a support shaft 30. The sprockets 28 are spaced in a direction transverse to the conveying direction so as to align with corresponding engagement structures on the chain C (such as the connectors in the gaps G between the laterally repeating sections L_3), and may each be split in order to facilitate installation and removal without removing the support shaft 30 from the mounted position. Of course, the spacing and number of the sprockets 28 may vary, depending on the particular type of chain C used. Instead of sprockets 28, a drive roller may be substituted for frictionally engaging and driving a belt (which could be fabric or rubber) or even the chain C, although depending on the materials used, this may be deleterious from both an efficiency and wear standpoint.

One possible advantage of the conveyor 10 forming part of the present invention is that it may be easily adapted for slaving to a drive unit U (including a motor) associated with an adjacent conveyor, such as the adjacent (infeed) conveyor 12. Since the drive unit U includes a motor for driving the conveyor 12 (see Figure 7), this advantageously avoids the need for providing a separate electric motor or other motive device for the conveyor 10. This not

only allows for the conveyor 10 when used in a transfer arrangement to be more compact, but also reduces the complexity and cost. The modular nature of the components of the transfer conveyor 10 also makes it readily adaptable for use with most existing types of infeed and discharge conveyors without significant effort or the need for extensive retrofitting.

To create the desired slave drive arrangement, the ends of the support shaft 30 may be journaled in bushings 32, 34, as shown in Figure 7. Each bushing 32, 34 is supported by a frame including a pair of side frame members 36, 38. The side frame members 36, 38 are connected by structural members, such as tie rods 39, and also carry bushings 40, 42 at the opposite end for receiving a portion or extension of the drive shaft 44 forming part of the drive unit U that drives the belt B, chain, or like conveying medium on the adjacent conveyor 12. An extension of the drive shaft 44 adjacent to one lateral side of the transfer conveyor 10 is coupled to a drive sprocket 46, which engages a drive belt or chain 48 that in turn causes a driven sprocket 50 coupled to the corresponding end of the sprocket support shaft 30 to rotate. A tensioner for tensioning the drive chain 48, such as an idler sprocket 52, is also supported by and journaled in the corresponding side frame member 38 (and the corresponding support shaft (not shown) may extend over to and be journaled in side frame member 26 as well). As shown in Figure 2, this entire drive subassembly may be provided with a cover 54 to protect the moving parts by guarding against external interference.

To avoid disrupting the flow of conveyed articles, the sprockets 46, 48 are preferably selected to ensure that the chain C of the conveyor 10 is driven at substantially the same speed as the belt B or chain on the adjacent conveyor 12. However, it is also possible to size the sprockets 46, 48 such that the chain C of the conveyor 10 when used as a transfer moves slightly

faster than the belt B on the adjacent conveyor 12 to accelerate the articles slightly and widen any gap or spacing present. Of course, a conveyor 10 with a slower running chain C could also be used in an effort to accumulate articles being conveyed or close any gap or space present. In both cases, the direction of travel generally remains the same.

As should be appreciated, because the bushings 40, 42 attached to the side frame members 36, 38 journal the drive shaft 44, the entire drive subassembly including the side frame members 36, 38 and the support shaft 30 may freely pivot about the axis thereof, and is generally urged toward the corresponding surface of the chain C as the result of gravity. To counteract the effects of gravity on this subassembly and, thus, the associated tensioning force applied to the chain C, a counterbalancing means or mechanism is provided. In one possible embodiment, this means or mechanism comprises a constant force spring 56 supported by the frame member 20 for engaging a stub shaft 58 that projects through a slot 60 formed in the adjacent side frame member 36 defining the range of pivoting movement. The spring 56 may be fastened to the bushing 40 for the drive shaft 44. A similar mechanism may also be provided on the opposite side of the conveyor 10 (note stub shaft 58 projecting from the fixed frame member 20 in Figure 6).

Each mechanism (spring) when oriented as shown effectively urges the drive shaft 30 away from the chain C (i.e., in a direction generally opposite to the direction of gravity). However, gravity urges the support shaft 30 toward an inside surface of the chain C (e.g., generally downwardly, but slightly toward the conveyor 12 because of the arcuate shape of the slot 60 in which the stub shafts 58 travel; see action arrow D in Figure 1). By balancing the competing forces, the sprockets 28 are kept in engagement with the corresponding surface chain C in a consistent and even manner to provide just

the right amount of tension. This advantageously ensures that the chain C is driven through the conveyor 10 in an even, smooth manner without binding or slipping. Nevertheless, in the case where the chain C needs to be adjusted or removed, the tensioning force created is easily overcome or removed by simply lifting up on the shaft 30. A related advantage of the resulting balanced force is the concomitant automatic or self-tensioning of the drive chain 48 when the optional slave drive is used.

With specific reference to Figure 6, an optional feature is to adjustably mount the conveyor 10 for selective positioning at an incline or decline relative to the adjacent conveyor 12. Specifically, an arcuate slot 62 may be provided in each side frame member 18, 20 for receiving fasteners F mounted to the side frame or bed 11 of the adjacent conveyor 12. By tightening or securing the fasteners F against the corresponding surface of the frame member 18, 20, the angle or tilt of the conveyor 10 relative to the adjacent conveyor 12 may be fixed. Thus, the conveyor 10 may be oriented generally parallel to a horizontal plane, as shown in the drawing figures, or may be tilted in either direction a certain range, as defined by the length of the arcuate slot 62 (e.g., ±15°). As should be appreciated by those of skill in this art, this feature is advantageous when one of the adjacent conveyors is positioned in a different horizontal plane (i.e., either above or below) the other. The driven nature of the chain C also allows the transfer conveyor to be positioned at a greater angle of inclination without resulting in product stalling than is possible when using a passive, roller type transfer conveyor. Incorporating one of the several embodiments of high-friction and cleat chains disclosed in patent application Ser. No. PCT US03/05666 may also help in situations when the conveyor 10 is used for conveying articles from one location to another along an incline.

A second embodiment of the driven conveyor 100 forming part of the present invention is shown in Figures 8-16. This embodiment is similar in that the conveyor 100 may be positioned in juxtaposition to one end of a conveyor 12 (note bed 11), and includes an endless belt or chain C that may be slave driven by the drive unit U associated with the conveyor (see motor M in Figure 8 supported from the adjacent conveyor 12 by a bracket K (see Figure 16)). However, the conveyor 100 of this embodiment does not include any "floating" subassembly for supporting the drive structure.

Accordingly, instead of using a sprocket 52 for tensioning the drive chain 48 (as is done in the first embodiment as a result of the pivoting movement of the frame members 36, 38 about the transverse axis defined by the drive shaft 44), a pivotally mounted arm 102 supports or carries a camming structure 104. This camming structure 104 may be semi-circular and thus includes a curved or contoured face adapted for engaging an outer surface of the drive chain 48. The force for moving the arm 102 and hence camming structure 104 into engagement with the chain 48 is supplied by a torsion spring 103. As perhaps best shown in Figure 12, the spring 103 may be mounted over a post P formed in a recess 111 in a housing 110 for the drive subassembly such that one leg 103a engages an adjacent (upper) wall of the housing and the other leg engages the adjacent (upper) surface of the arm 102 and, consequently, moves the camming structure 104 into engagement with the drive chain 48 (see Figures 9, 10, and 12). A pivotally mounted chain guard 105 may also be supported by the housing 110 (see Figure 12).

A second difference is that, instead of tensioning the chain C using a pivotally mounted drive structure, the conveyor 100 of this embodiment includes a movable or "floating" idler structure. Specifically, the ends of one of the idler structures, such as roll 24, extend through slots 106,

107 formed in side frame members 108, 109 supported by the end of the adjacent conveyor 12 (see Figures 13, 14, 15, and 16). One side frame member 108 in turn supports the housing 110, and the other side frame member 109 supports a second, similarly constructed housing 112 on the opposite side of the conveyor 100. Each housing 110, 112 also includes a slot or elongated opening 114, 116 for receiving the ends of one of the idler structures, such as roll 24. A bearing 113 may be provided for sliding to and fro with the idler structure or roll 24 in a recess 115 surrounding each elongated opening (see opening 114 in Figure 13). As a result of this arrangement, the idler structure or roll 24 is capable of "floating," or moving to and fro in and relative to these slots or openings 106, 107 and 114, 116. Protective covers 117 are also provided for the housings 110, 112.

To provide tensioning if desired, a mechanism or means is provided for urging the "floating" idler structure into engagement with an outer surface of the chain C along the return run (such as at the transition between a non-horizontal or vertical portion to a horizontal portion, in the situation where the return path is T-shaped as shown in the drawing figures)). In the preferred embodiment where the chain C is driven in a counterclockwise direction when viewed from the right hand side when facing the end of the conveyor 12 (see, e.g., action arrow A in Figure 10 representing the conveying direction), the tensioning mechanism or means comprises a pair of constant force springs 118. The springs 118 are fixedly mounted to each housing 110, 112 at one end and have a free end for urging the idler roll 24 into engagement with the outer surface of the chain C (that is, to the left in Figure 10).

Each spring 118 or other mechanism used is selected so as to provide a substantially constant amount of force for causing the idler roll 24

or other idler structure to engage and automatically tension the chain C over the drive structure, such as the plurality of gang-driven sprockets 28 mounted on a common drive shaft 30. Instead of a constant force spring, an alternative is to use a different type of spring for pushing the idler structure toward the chain C (see Sanki Engineering's U.S. Patent No. 5,871,085, the disclosure of which is incorporated herein by reference), although this increases the space requirements and may thus be less desirable. In either case, the housing 110 may be provided with a stable support structure, such as a mounting projection 119 (see Figure 12), for engaging the opposite (free) end of the spring 118 or otherwise supporting the urging mechanism.

The entire conveyor 100 of this embodiment may also be adjustably mounted for pivoting about the axis defined by the drive shaft 44 (see double headed action arrow Y in Figure 10). To accomplish this, both frame members 108, 109 and the corresponding housings 110, 112 are provided with slots 108a, 110a; 109a, 112a for receiving suitable fasteners F that extend into and are supported by the frame or bed 11 of the adjacent conveyor 12. As explained above, by securing the fasteners F against a corresponding surface of the frame member 108, 109, the angle or tilt of the conveyor 100 may be fixed relative to the adjacent conveyor 12.

Referring to Figure 11, the bed 14 in this embodiment is shown as being formed of two identical pieces of an elongated or plate-like wear-resistant structure 124 (preferably coated with UHMW polypropylene) secured to a support structure 126. The support structure 126 may include a projecting portion for resting in a notch 128 formed in each side frame member 108, 109, as well as a recess 130 formed in a portion of each housing 110, 112 and a pair of support brackets 127 fastened to the support structure 126 for supporting the wear-resistant structure 124. This mounting

arrangement secures the bed 14 against movement to and fro or from side-to-side, but allows it to be easily lifted in the vertical direction when the chain C is slackened or removed. An optional, generally L-shaped guard 132 may also be secured to the frame members 108, 109 (such as on flanges 108b, 109b), or instead may be secured to housings 110, 112.

A portion of the "floating" idler structure, such as roll 24, may also extend through both covers 117. Figure 16 shows an opening 117a formed in the drive-side cover 117 for receiving this end of the roll 24. The projecting end of this roll 24 on both sides of the conveyor 100 may be secured to a clip 140. During normal operation, these clips 140 simply remain in position adjacent to the outer surface of the cover 117 and freely move along with the corresponding shaft (not shown) or other extension of the roll 24 to which it is attached. When it is necessary to release the tension on the idler structure, such as roll 24, the clips 140 are manually grasped and moved such that an inwardly protruding end of each is received and captured in an opening 117b formed in the cover 117. This feature advantageously allows for adjustments to be made to the chain C when slackened, or allows for the chain to be removed altogether, without requiring full or even partial access to the constant force spring 118 or other mechanism for urging one idler structure into engagement with the outer surface of the chain C (that is, without the need for removing the covers 117 or any other components).

As should be appreciated from Figures 13 and 16, the plates 108, 109 and housings 110, 112 also include suitable openings for receiving the drive shaft 44 and the support shaft 30. Only the housings 110, 112 are shown as including an opening for receiving the other idler structure or roll 22. As with the first embodiments, suitable bushings or bearings may be provided for rotatably supporting any or all of these structures.

A third embodiment of the conveyor 200 shown in Figure 17. This embodiment is also adapted for being supported by an adjacent conveyor 12 and slave driven by the corresponding drive unit (not shown). One modification in this embodiment is an adjustment to the manner in which the "floating" idler structure, such as for example roll 24, is tensioned. Specifically, in the embodiment shown in Figure 17, the chain C is driven in the direction of action arrow A, preferably by slaving the drive shaft 30 to the drive unit of the adjacent conveyor substantially as described above, and the idler structure (roll 24) closest to the adjacent conveyor is mounted for floating movement in a generally horizontal plane, toward the opposite idler structure (roll 22). A pair of side frame members 202 include elongated slots 204 through which the ends of both idler structures or rolls 22, 24 pass. The ends of these structures or rolls 22, 24 extend through an elongated or oblong tensioner bushing 206 connected to and supported by each side frame member 202. Each frame member 202 also includes a suitable opening for receiving the ends of driven shaft 30, a slot for positioning over the drive shaft 44 of the adjacent conveyor, and machined holes as necessary for receiving fasteners (including those for holding any bushings or covers in place).

A tensioner or tensioning means is provided, which includes a means for urging one idler structure or roll 22, 24 into engagement with the corresponding outer surface of the chain C along the return run (which is shown as having a T-shaped path including a first horizontal portion, a non-horizontal portion created by the training of the chain C over the first idler structure or roll 22, and a second horizontal portion created by the training of the chain over the second idler structure or roll 24). In the illustrated embodiment, the urging means forming part of the tensioner includes a constant force spring 208 for positioning along each side of the transfer

conveyor 200. A first free end of each spring 208 is fixed to the corresponding bushing 206 by a fastener F. Each spring 208 is then wrapped around the fixed idler structure (roll 22 in this case) and the opposite, coiled end engages the corresponding end of the idler structure or roll 24.

An oblong retaining plate or cover 210 sized to cooperate with each tensioner bushing 206 is positioned over the ends of the idler structures or rolls 22, 24 and secured in place, such as by placing a retainer clip over the end of at least the non-floating idler structure or roll 22 (and possibly over the other as well). Each cover 210 includes a first opening for receiving and fixing the position of one idler structure, such as structure 22 in Figure 17, and a second, oversized opening for allowing the other idler structure (roll 24 in this case) to move to and fro.

As a result of the tension force supplied to each end of the idler structure or roll 24 by the urging means, such as the constant force spring 208, it is thus urged toward the opposite idler structure or roll 22 and into contact with the outer surface of the chain C. This serves to tension the chain C in the conveyor 200 as it is driven in the direction of action arrow A along the generally T-shaped path by the drive sprockets 28. As should be appreciated, the tensioning mechanism is thus very simple and compact as compared to those in the prior art (see, e.g., the Dolan '296 patent), which helps in reducing the overall size and complexity of the conveyor 200.

To release the tension on the chain C, the operator simply moves the ends of the idler structure (roll 24) such that the force supplied by the spring 208 is overcome. Preferably, this may be accomplished by mere finger action or by using a simple tool for leverage. If it is desirable to hold the idler structure in this position for an extended period of time, the cover 210 may be reoriented and returned such that the end of the floating idler structure (roll

24) passes through and engages the smaller, or non-oversized, opening. This engagement thus holds the "floating" idler structure (roll 24) out of engagement with the chain C, which is therefore in a slackened state. In any case, servicing and inspection, including of the bed 14, are greatly facilitated as a result of the ease with which the tension on the chain C is released.

Through experimentation, it has been discovered that in some situations, including when the chain C is driven in a direction opposite that of action arrow A (that is clockwise when viewed from the right, as in Figure 1), it is desirable to allow the other, or first idler structure 22 to float while fixing the second idler structure 24 closest to the adjacent conveyor 12. As should be appreciated, the tensioning arrangement disclosed for use in this third embodiment is easily reversible for achieving this result. Specifically, the covers 210 are simply removed and the urging means is adapted for urging the first idler structure, such as roll 22, into engagement with the corresponding outer surface of the chain C. This may be accomplished by simply reorienting the constant force spring 208 within each tensioner bushing 206. In either case, the cover 210 is then returned and secured in place, such that the ends of idler structure or roll 24 remain fixed in the corresponding openings, while the ends of idler structure or roll 22 remain free to move within the corresponding slots as a result of the urging force supplied by the springs 208.

An optional feature of the embodiment depicted in Figure 17 is to include oversized tubes or bushings 212 as part of each idler structure, such as by positioning them directly on the rolls 22, 24. The outer surfaces of these bushings 212 thus engage the outer surface of the chain C and rotate about the corresponding support shaft 214 as it moves through the transfer conveyor 200. Preferably, these bushings 212 are made of a highly wear-resistant

material, such as UHMW polypropylene. Optional bushings 216 may also be supported by the ends of the shafts 214 forming part of each idler structure. In the illustrated embodiment, the outer diameters of these bushings 216 correspond to the inner diameter of the corresponding portion of the constant force spring 208 and the opening in each cover 210. It is also noted that the bed 14 (which is shown as including two substantially identical plates 14a, 14b connected to the support structure 16 by fasteners) is also supported by a support structure 16 adapted to fit in slots or notches formed in the side frame members 202. This allows for the easy removal of the bed 14, such as for inspection or replacement, once the chain C is slackened or removed.

As noted above, each side frame member 202 may be mounted to the adjacent conveyor 12 by fasteners that extend through an arcuate slot 62 formed therein. As described above, this allows for the transfer conveyor 10 to be tilted relative to the adjacent conveyor 12, such as when the discharge conveyor (not shown) is in a different horizontal plane. The pivoting is about the ends of the drive shaft 44 of the adjacent conveyor, which as mentioned above are received in slots formed in the side frame members 202 (and may include appropriate bearings or bushings to facilitate free rotation therein).

A fourth embodiment of a conveyor 300 is shown in Figures 18-24. In this embodiment, the conveyor 300 is comprised of two sub-assemblies: (1) a bed subassembly 302; and (2) a mounting base subassembly 304 for receiving and supporting the bed subassembly 302. In the illustrated embodiment, the mounting base subassembly 304 includes a frame or base 305 supported from the end of an adjacent conveyor 12, such as by a fastener F. As described above, the fastener F may pass through an arcuate slot 306 formed in each side of the base 305. It should be appreciated that this arrangement allows for changing the angle of the base 304 (and hence the bed

assembly 302 supported thereby) relative to the adjacent conveyor 12. In the case where the conveyor 300 is used in a slave arrangement, an opening 308 may also be provided through which a shaft 310 carrying a gear or sprocket 312 at one end may pass. The other end of the shaft 310 may be associated with a motive device, such as a variable speed electric motor, for driving the adjacent conveyor 12.

With continued reference to Figure 18, the base 305 also includes sidewalls including generally U-shaped cutouts 305a for receiving a portion of the bed subassembly 302 or a structure associated with it. One or more notches 305b are also provided adjacent to the cutouts 305a for performing a similar function, as outlined further in the description that follows. The floor 305c of the base 305 may also be provided with apertures 305d for allowing cleaning fluids to pass. A generally vertical front wall 305e also serves as a guard for the bed subassembly 302. Structures such as shafts 311 projecting from the base 305 may also support a removable cover 313 to guard the drive sprocket 312, any transmission chain (not shown), and any other movable structures present.

Turning to the bed subassembly 302 and the partially exploded view of Figure 19, it generally includes a frame or body defined by a pair of spaced side frame members 320 or plates. The side frame members 320 as shown include openings in the form of slots 321 for receiving support rails 322 for supporting the bed 324, which in turn supports and guides the conveyor chain C (which may be constructed similar to as is described elsewhere herein) and for supporting a transfer comb 323 or like structure (unitary or otherwise). Each side frame member 320 also includes an opening 326 through which the ends of a driven structure, such as a drive shaft 328 carrying a plurality of sprockets 330 for engaging the chain C, may pass (see

Figure 20).

The frame members 320 also include openings 331 for receiving the stub shafts (which may be the ends of threaded fasteners F) that support a first idler structure, which is shown in the form of a shaft 332. As described above, this idler shaft 332 may be fixed against rotation and provide support a plurality of tubular bearings or rollers 333 that make rolling contact with the outside surface of the chain C as it traverses along the endless path (which as indicated is preferably T-shaped).

The side frame members 320 also include elongated slots 334 for receiving the ends of a second idler structure or shaft 336 (which may also be fixedly mounted and carry tubular bearings or rollers 333 for engaging the chain C). As with the embodiment described above, this arrangement allows this second idler shaft 336 to move toward and away from the adjacent outer surface of the chain C and provide a tensioning function. Suitable bushings and bearings (collectively labeled with reference numeral 338 in Figure 20) may also be provided for the drive shaft 328 and the second idler shaft 226, as necessary or desired to reduce wear and increase the service life of the conveyor 300.

To urge the "floating" idler structure or shaft 336 toward the chain C in this third embodiment, a tensioner 340 is provided. As shown in the exploded view of Figure 21 and the side view of Figure 22, the tensioner 340 includes a pair of spaced arms 342 connected by a first cross member 344 (not shown in Figure 21, but see Figure 19) and a second cross member 346 oriented generally parallel to the first cross member. The arms 342 are carried and pivotally supported by the first cross member 344 (which may include suitable bushings 345 and locking collars 347 for establishing a secure connection; see Figure 21), which is in turn supported by the side frame

members 320 of the bed subassembly 302. At one end, each arm 342 includes a projection or finger 348 for adapted for engaging a corresponding portion (end) of the second idler structure or shaft 336. The second cross-member 346 is attached to the opposite end of the arms 342 using suitable fasteners F. Each arm 342 includes an optional elbow 349 or bend that allows it to fit within the confined space provided while maintaining the desirable large moment arm to maintain the appropriate amount of tension.

As perhaps best understood with reference to Figure 22, the second cross member 346 functions as a weight (note the direction of gravity G) and causes the arms 342 to pivot about the first cross-member 344 (note action arrow H). As a result, the projection or finger 348 is urged against the adjacent second idler structure or shaft 336. This in turn urges this idler structure or shaft 336 (which is free to move or float within the slot 334 and any bushing or bearing present) against the adjacent outer surface of the conveyor chain C. Consequently, the appropriate amount of force is provided to properly tension the chain C in the conveyor 300. Moreover, the urging force applied may be easily adjusted by changing the size or composition of the second cross-member 346.

As the width of the conveyor 300 increases, the width of the second cross-member 346 increases. This, in turn, increases the weight of this member 346. The result is a desirable increase in the urging force in response to the increased tension force created by the wider chain C.

In operation, the bed subassembly 302 constructed as described above and as shown in Figure 19 is positioned such that the bushings 338a for the drive shaft 328 rest in the U-shaped cutouts 305a. In the slave drive situation, a suitable sprocket or gear 350 is secured to the exposed end of the shaft 328 and operatively connected to the corresponding sprocket 312 of the

adjacent conveyor section 12. However, it is also entirely possible to use a direct drive arrangement with a separate motor. In either case, the sprockets 330 thus engage the chain C and drive it along the endless path defined while the tensioner 340 supplies the appropriate amount of resistance to the "floating" idler shaft 336, independent of the movement of the support members 320.

To reduce the amount of rocking movement experienced by the bed subassembly 302 as the chain C is driven, structures may be provided for engaging the notches 305b. In the illustrated embodiment, these structures are in the form of detents 352 carried by the side frame members 320 and slidably received in the notches 305b. As should be appreciated, even with these anti-rocking or seating structures, the bed subassembly 302 may still be freely raised and lowered relative to the base subassembly 304 when the shaft 338 is disconnected from a motive device or related structure (e.g., the chain forming part of the slave drive or a direct drive/motor). This makes the bed subassembly 302 fully releasable in the event of a jam or when service is required, with the chain C remaining intact if desired.

Finally, Figures 23 and 24 illustrate the manner in which the bed 14 may be formed in two or more generally L-shaped sections 14a . . . 14n. These sections may be mated together over the support 322 and held together using fasteners F. As noted above, the sections 14a . . . 14n may be aluminum extrusions, which are both lightweight and durable.

The foregoing descriptions of various embodiments of the invention are provided for purposes of illustration, and are not intended to be exhaustive or limiting. Modifications or variations are also possible in light of the above teachings. For example, despite the focus on transfer conveyors, the inventions described above (and in particular the fourth embodiment

shown in Figures 19-24) could easily be adapted for use as full-length driven conveyors for use either in a stand-alone environment or as part of a conveying system. This could be done by simply making the bed 14 and chain C the desired length, and then ensuring that the drive arrangement used is suitable for moving the chain at the desired speed. Instead of a slave drive using a chain, the drive could also be through direct engagement between the gears (e.g., gears 312 and 350 in the embodiment shown in Figures 19-24), or by way of a separate motor (including possibly one playing an assist role only). The embodiments described above were chosen to provide the best application to thereby enable one of ordinary skill in the art to utilize the disclosed inventions in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.